LOCKING AND UNLOCKING A MOBILE DEVICE USING FACIAL RECOGNITION

The various embodiments of the invention relate to locking and unlocking a mobile device. Other embodiments are also described.

BACKGROUND

Many mobile devices have a lock mode. The lock mode may be used to prevent inadvertent operation of a touch screen display, e.g., while the device is in a user's pocket or purse or when another object is placed against the device. The lock mode may also be used to prevent an unauthorized person from using the device. Generally, the device is programmed to enter the lock mode when a user presses a specific button or a series of buttons or when it has been idle for a certain period of time. When a user desires to use a device that is locked, the user will typically be required to drag a slide bar, press a specific button or a series of buttons (e.g., to enter a password) to unlock the device. However, a user may find these steps inconvenient and time consuming. For example, a user may be reading a document using the device when the device detects that it has been idle for a certain period of time. In this case, the device will automatically enter the lock mode where it turns off or dims its display screen, and the user will be required to unlock the device before being able to resume reading the document. In another example, a user may be prone to forgetting the password needed to unlock the device. As a result, the user may decide to configure the device so that it does not automatically lock. If she then forgets or chooses not to manually lock her device, that leaves the device susceptible to inadvertent operation or unauthorized use.

SUMMARY

In an embodiment of the invention, a mobile device is configured to automatically lock based on determining that a user's face is no longer present in images captured by the device's built-in camera. For instance, consider that the device is initially unlocked. In that state, a built-in camera captures one or more images, and the images are then analyzed to determine whether a user's face is present therein. If a user's face is not present in the images captured over a predetermined amount of time, the device automatically locks. Thus, the device is automatically locked when it determines that no user is currently using the device without having to wait for an idle timer to expire or a manual switch off by the user. The camera capturing and face recognition processing may be triggered by the device having detecting that it has been motionless for a threshold period of time.

In another embodiment, a mobile device is configured to automatically unlock. Consider that the device is initially locked. In that state, the camera captures an initial image. When movement of the device is detected, the camera captures a new image. The device then determines whether it has moved to a use position (i.e., a position that indicates that a user is likely to want to use the device) by comparing the new image with the initial image. If the device has moved to a use position, the camera captures a subsequent image, and the subsequent image is analyzed to detect a user's face. If a user's face is detected in the subsequent image, the device is automatically unlocked. This unlocks the locked device without requiring the user to press a sequence of buttons (e.g., to enter a password) each time the user wants to use the device.

The above summary does not include an exhaustive list of all aspects of the present invention. It is contemplated that the

invention includes all systems and methods that can be practiced from all suitable combinations of the various aspects summarized above, as well as those disclosed in the Detailed Description below and particularly pointed out in the claims filed with the application. Such combinations have particular advantages not specifically recited in the above summary.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will now be described with reference to the drawings summarized below. The embodiments of the invention are illustrated by way of example and not by way of limitation in the figures of the accompanying drawings in which like references indicate similar elements. It should be noted that references to "an" or "one" embodiment of the invention in this disclosure are not necessarily to the same embodiment, and they mean at least one.

FIG. 1 illustrates an example mobile device in use.

FIG. 2 is a block diagram of some of the constituent components of an example mobile device.

FIG. 3 is a flowchart showing the operations performed in the mobile device to implement the locking functionality.

FIG. 4 is a flowchart showing the operations performed in the mobile device to implement the unlocking functionality.

DETAILED DESCRIPTION

Several embodiments of the invention with reference to the appended drawings are now explained. While numerous details are set forth, it is understood that some embodiments of the invention may be practiced without these details. In other instances, well-known circuits, structures, and techniques have not been shown in detail so as not to obscure the understanding of this description.

FIG. 1 shows a mobile device 1 being held by a user 2 in a manner such that the device 1 is unlocked or remains unlocked by detecting a user's face. The device 1 may be any one of several different types of small consumer electronic devices that can be easily held in the user's hands during normal use. In particular, the device 1 may be any camera-equipped mobile device, such as a cellular phone, a smart phone, a media player, or a tablet-like portable computer, all of which may have a built-in camera. The device 1 may have an exterior front face in which there is a front-facing camera 3 and a display screen 4. As will be more fully explained below, camera 3 is used to capture an image of the device user 2 while the user is facing the display screen 4, in order to unlock the device 1 or to keep the device unlocked. Camera 3 may also be used to capture an image of the user 2 that may later be used to authenticate the user as an authorized user of the device 1.

FIG. 2 is an example block diagram of the device 1. The device 1 includes a main processor 18 that interacts with a motion sensor 11, camera circuitry 12, storage 13, memory 19, display 22, and user interface 23. The device 1 may also interact with communications circuitry 10, a speaker 20, and a microphone 21. The various components of the device 1 may be digitally interconnected and used or managed by a software stack being executed by the main processor 18. Many of the components shown or described here may be implemented as one or more dedicated hardware units and/or a programmed processor (software being executed by a processor, e.g., the main processor 18).

The main processor 18 controls the overall operation of the device 1 by performing some or all of the operations of one or more applications implemented on the device 1, by executing instructions for it (software code and data) that may be found